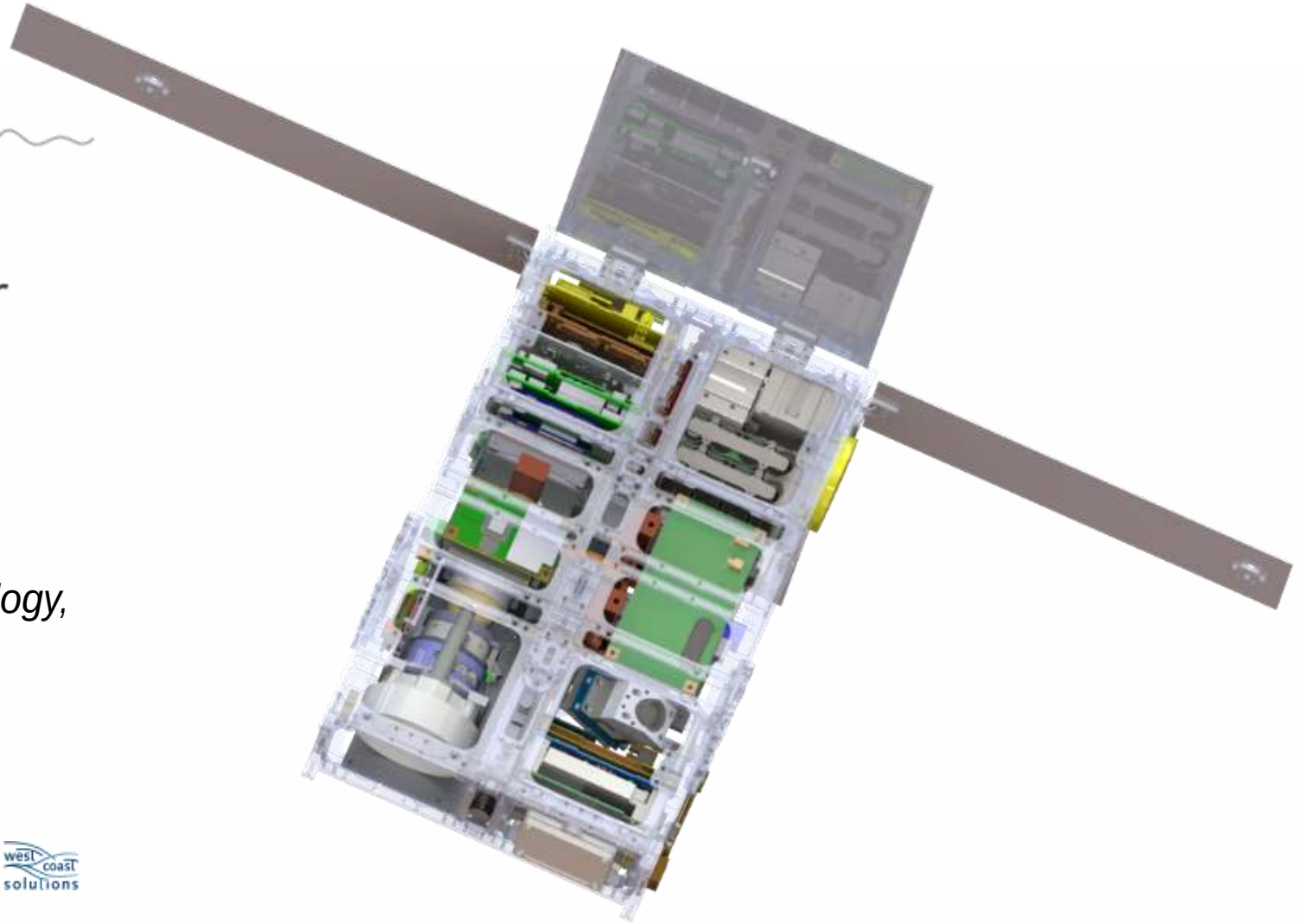
HyTI

Hyperspectral Thermal Imager



Presented by

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Hawai'i Institute of Geophysics and Planetology,
University of Hawai'i at Mānoa

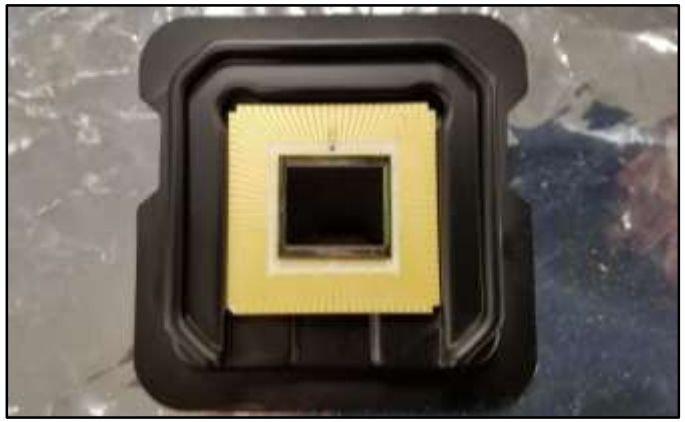
On behalf of the HyTI Team

HyTI Mission Goals

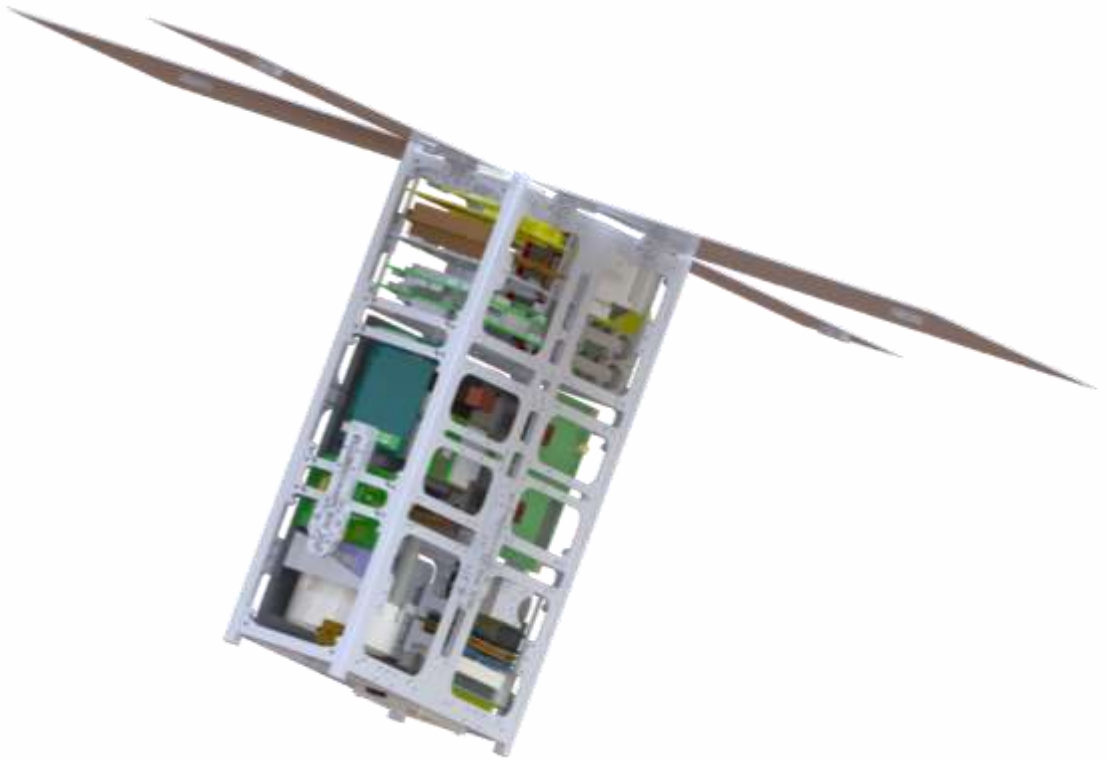
To demonstrate **high spectral, high spatial, and high SNR long-wave infrared imaging**, and **high performance on-board computing** to process the resulting data, on a **6U CubeSat** platform

1. HIGP Fabry-Perot LWIR imaging interferometer (TRL_{in} = 5)

2. JPL T2SLS Barrier InfraRed Detector (BIRD) focal plane array (TRL_{in} = 5)

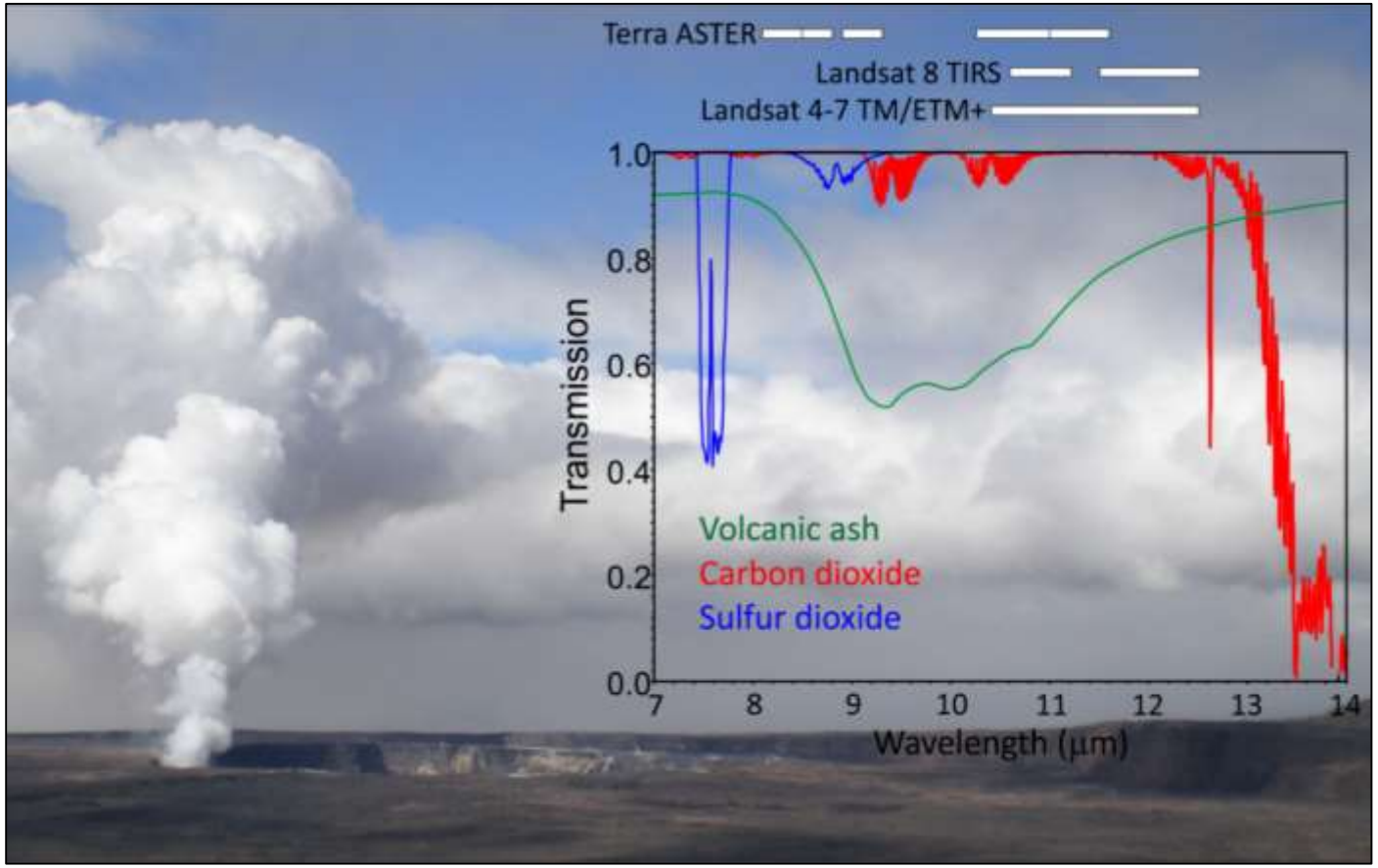


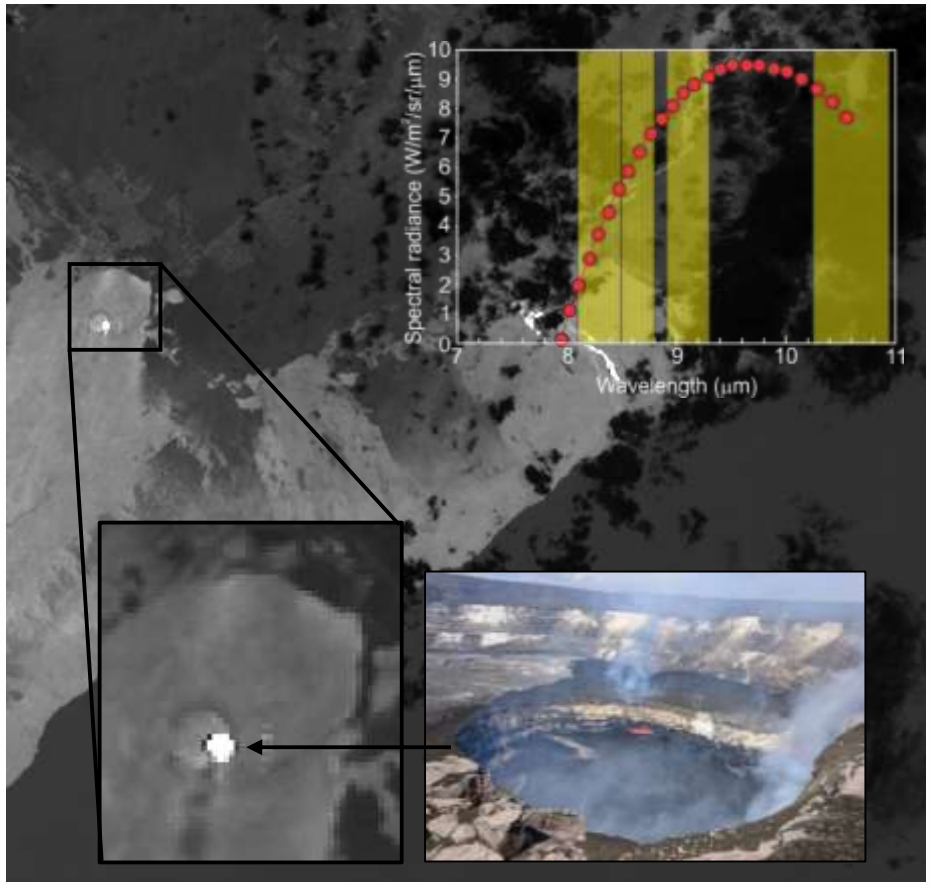
3. Unibap Deep Delphi iX5 heterogeneous onboard computer (TRL_{in} = 5)



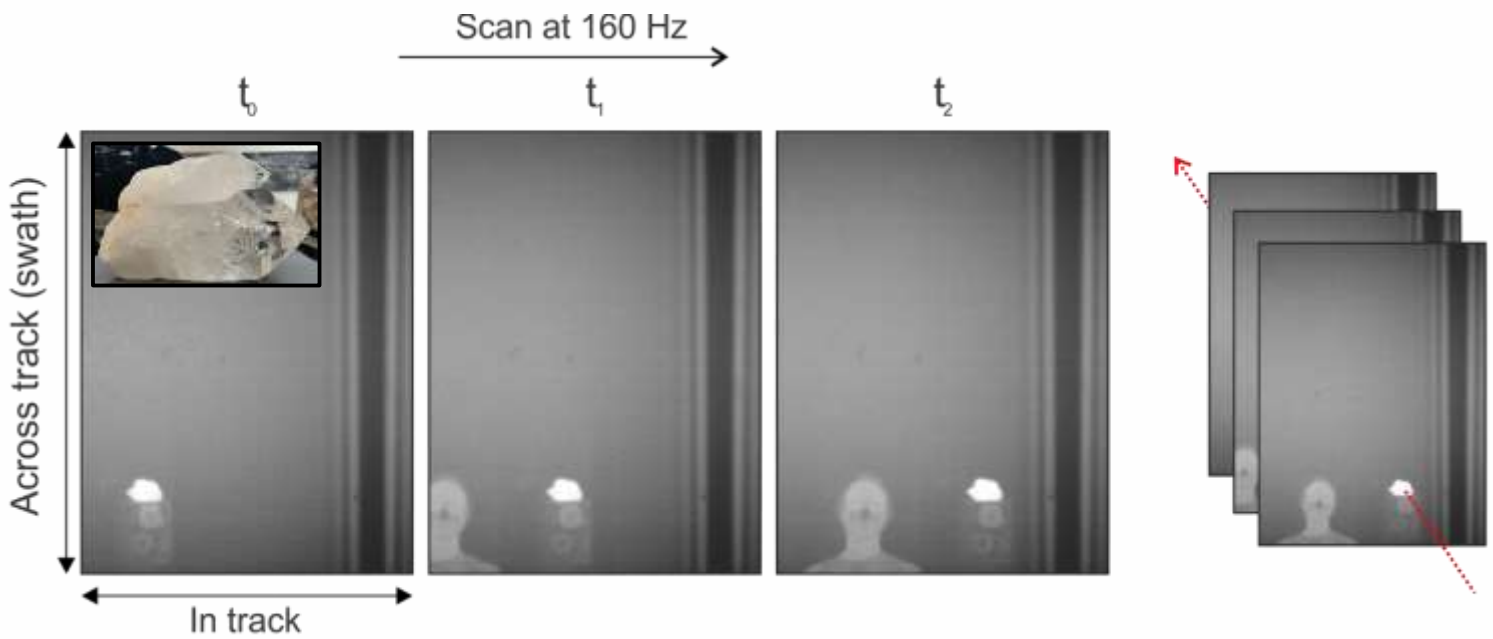
Relevance of HyTI to NASA's Earth Science mission

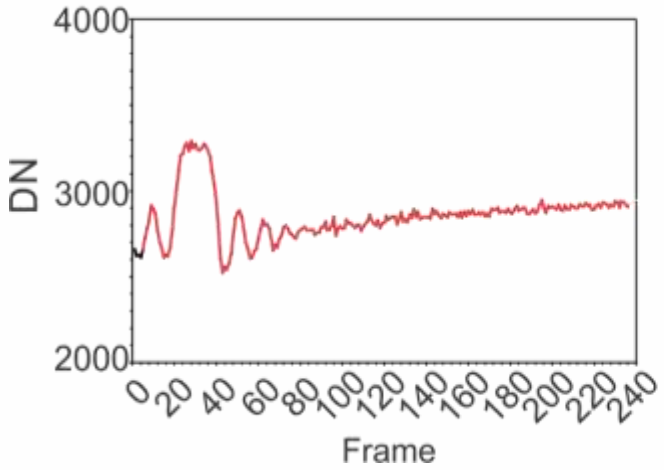
Earth scientists have never had access to high spatial and high spectral longwave infrared image data from Earth orbit

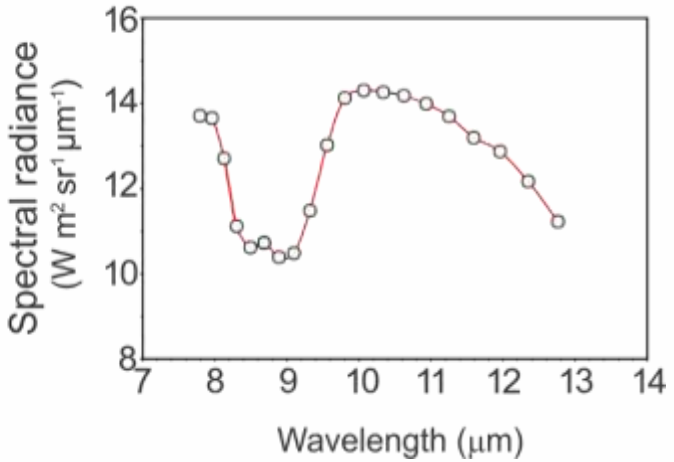


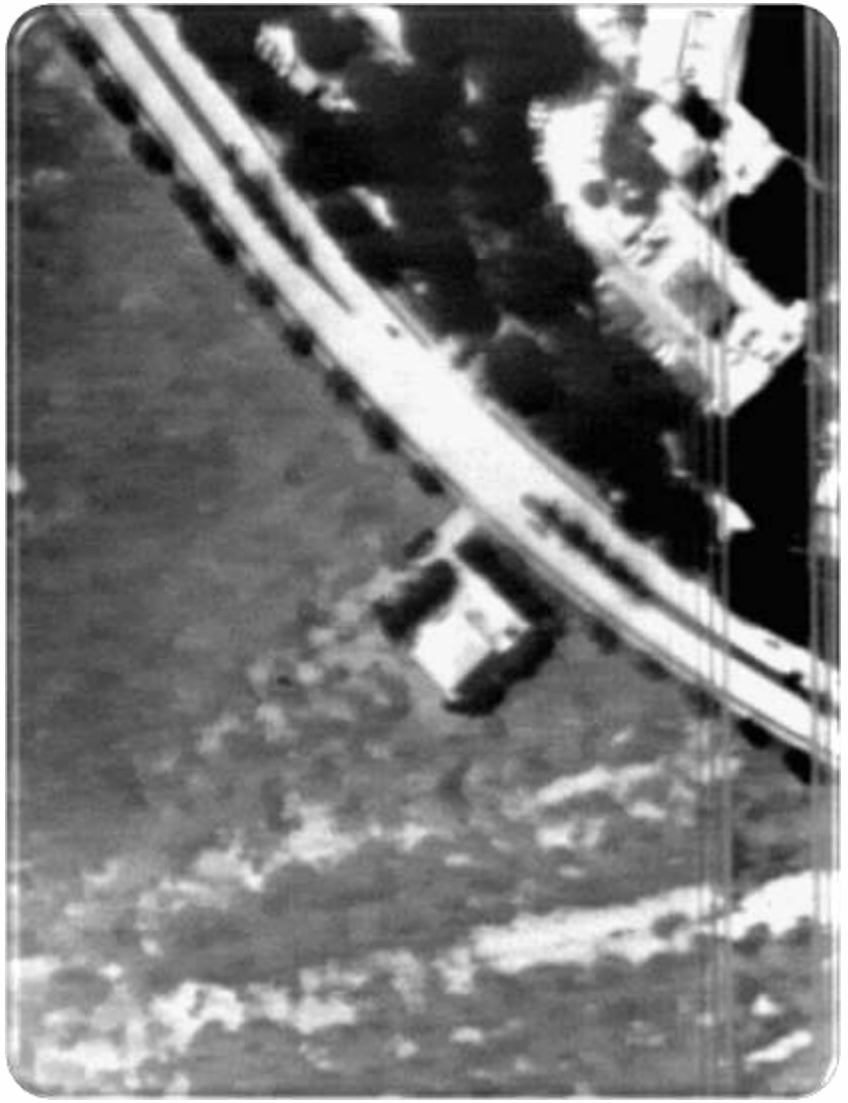


HyTI Measurement Approach

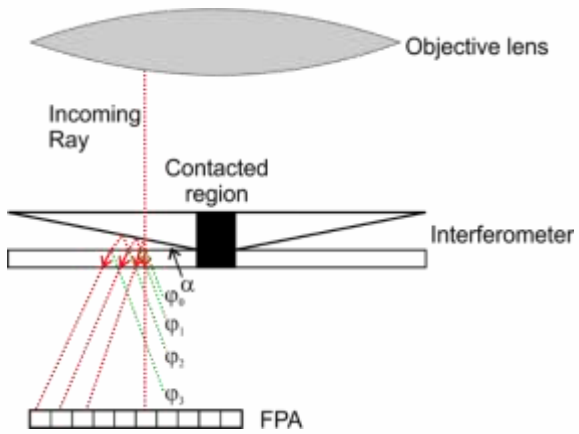


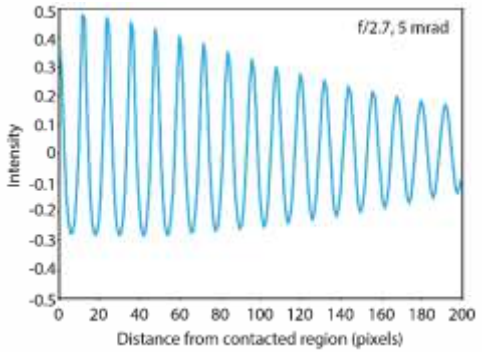


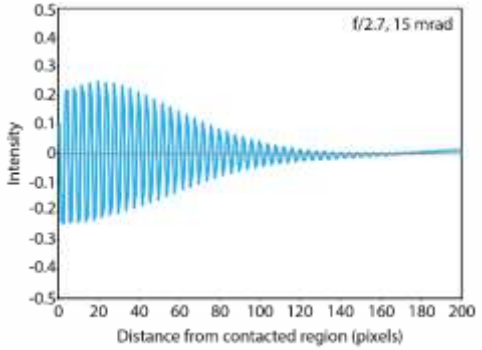


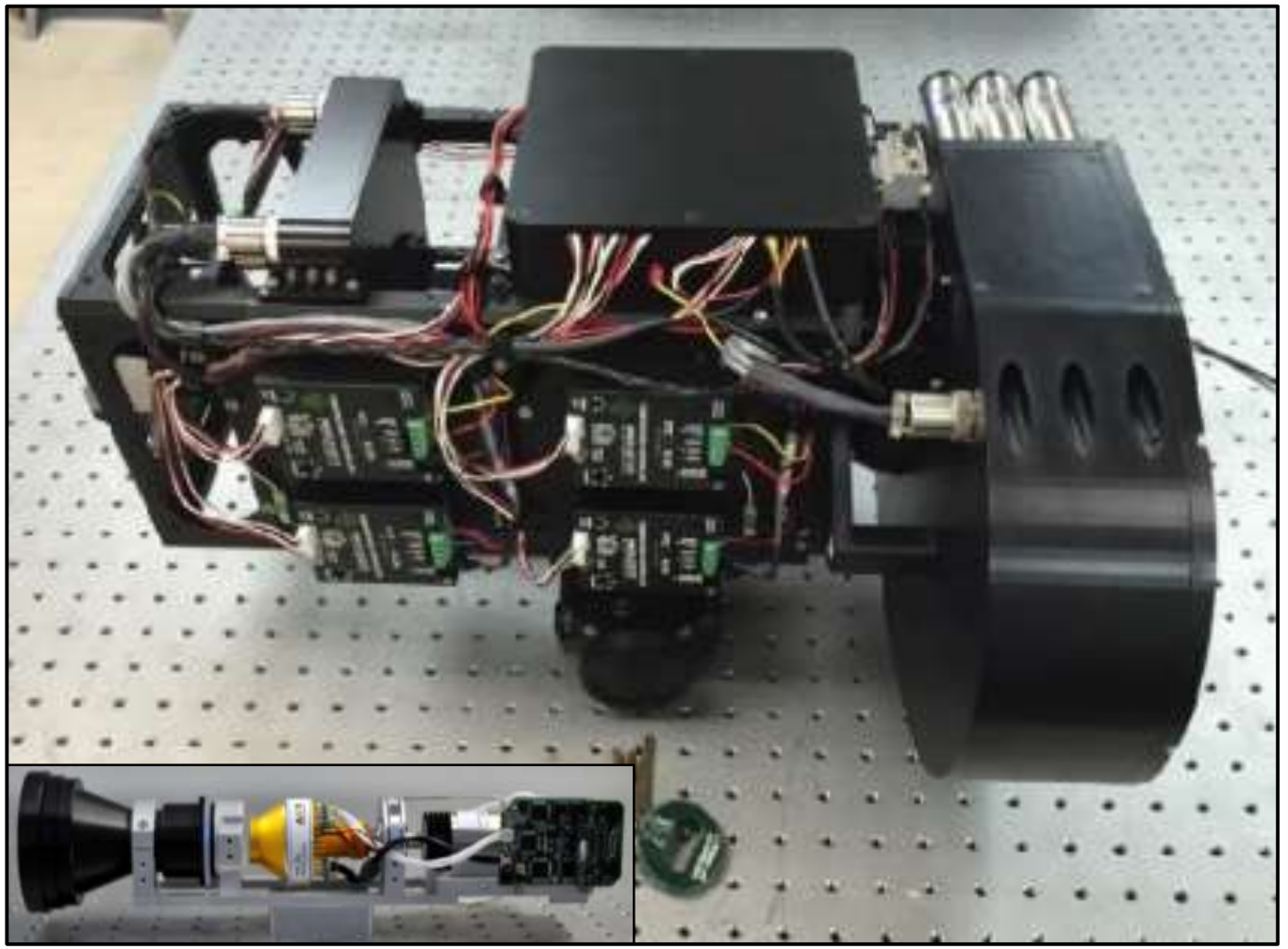


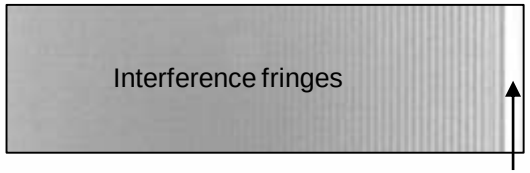
HyTI (cooled) makes TIRCIS (uncooled) smaller

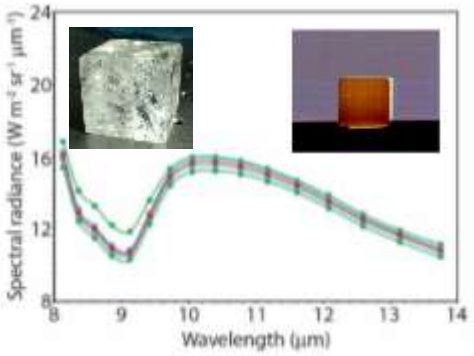


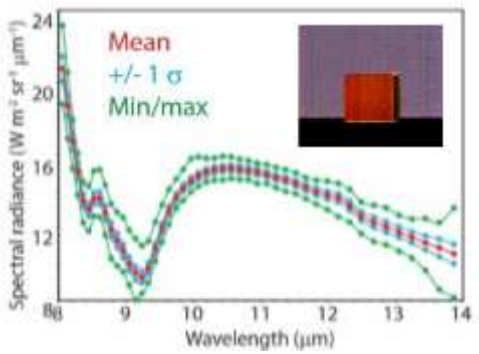




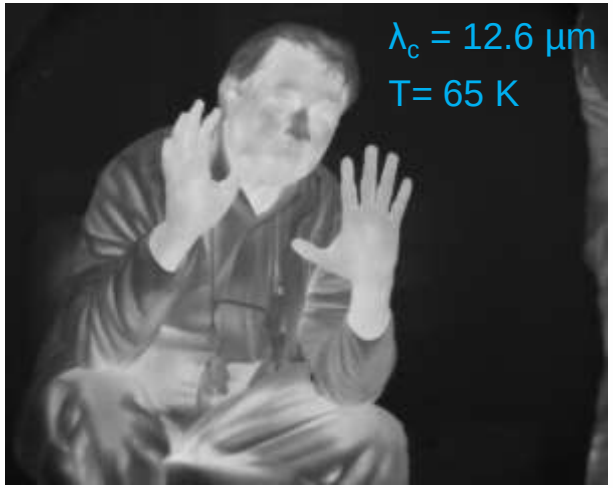






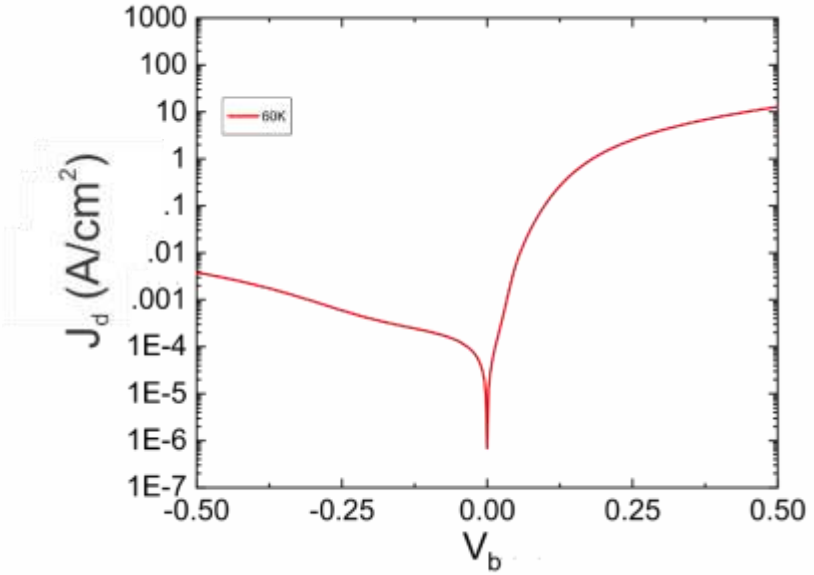


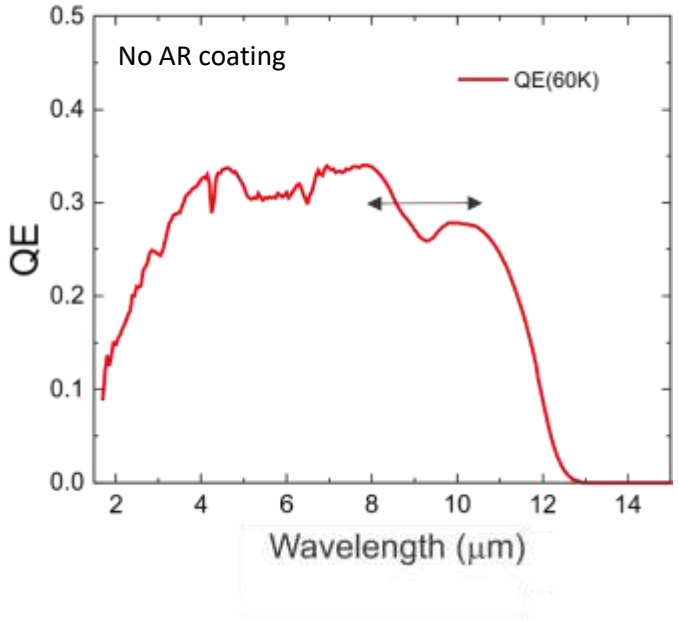
HyTI FPA: LWIR T2SL HOT-BIRD FPA



99.98% operability (18SLL03)

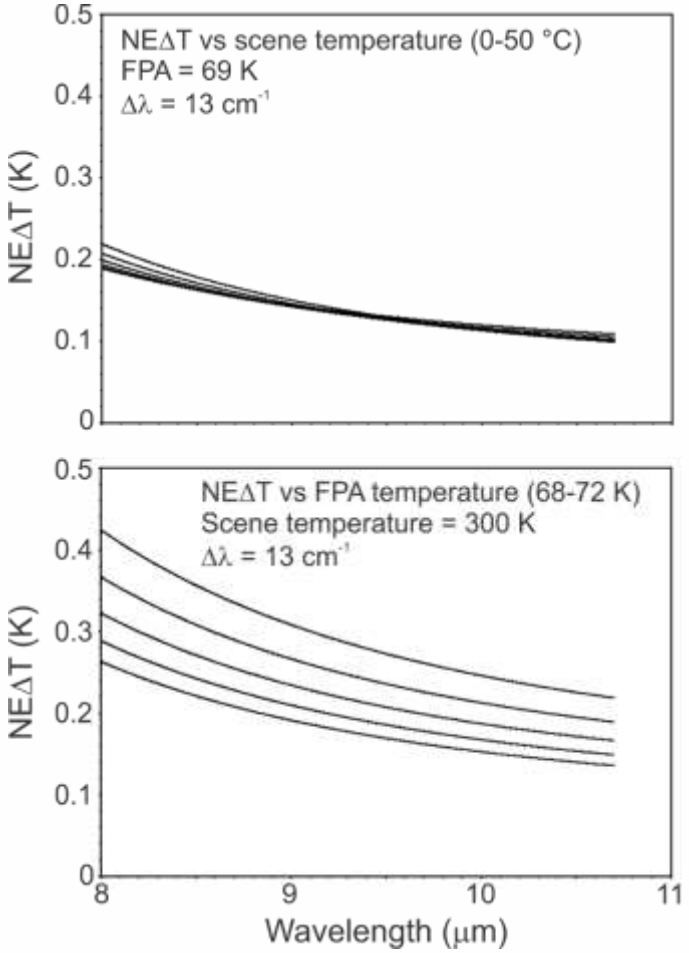
JPL developing T2SL-based LWIR detectors for
NASA Sustainable Land Imaging Technology (SLI-T) Program



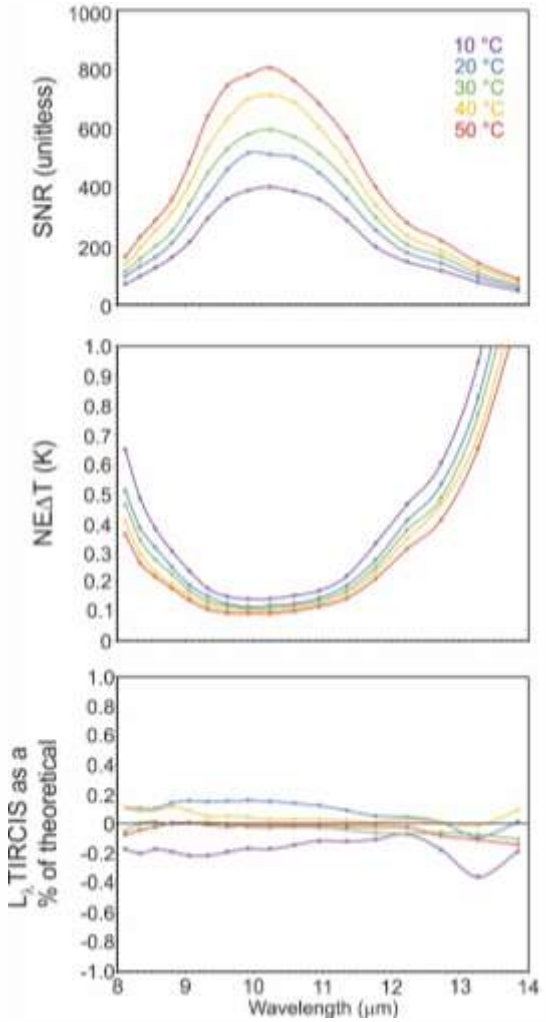


HyTI predicted instrument performance

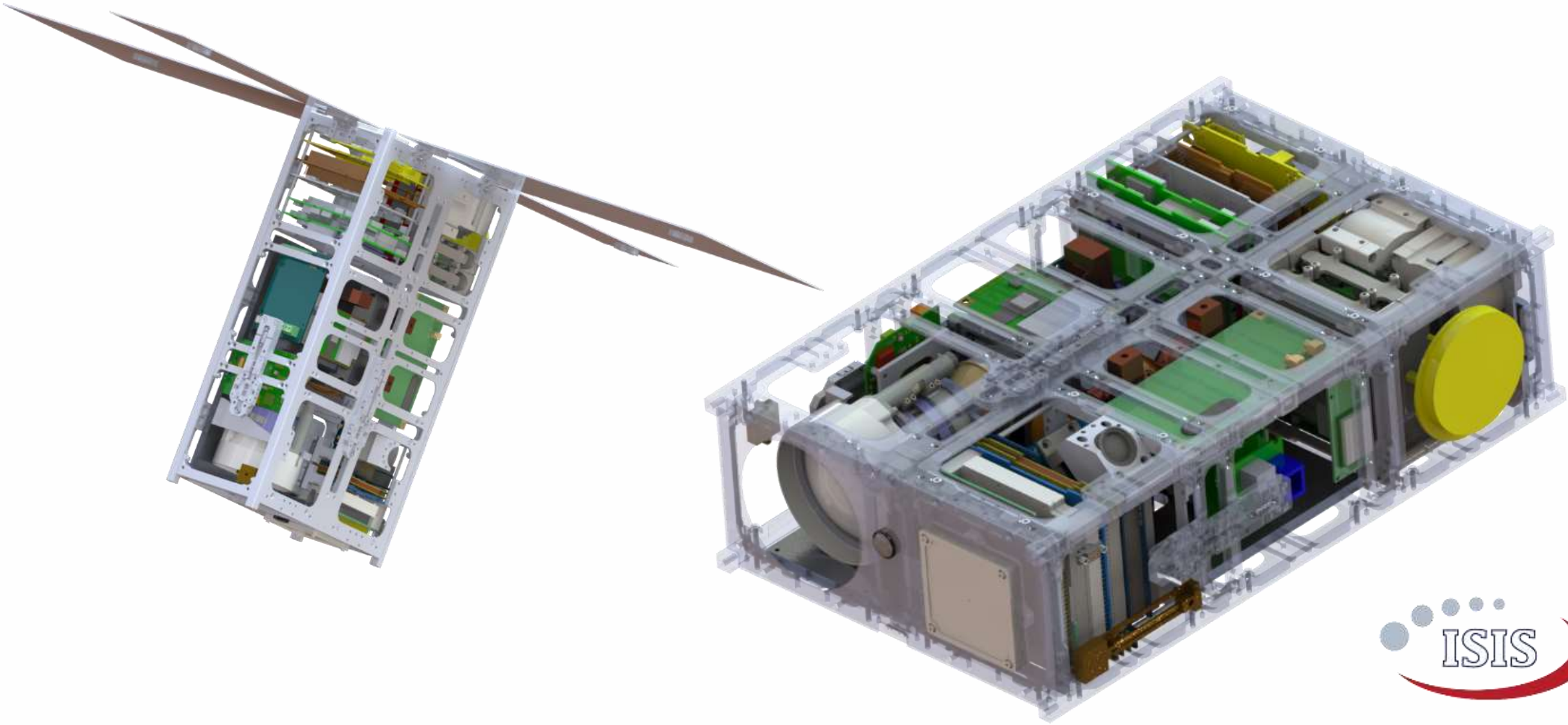
Parameter	Baseline
GSD	60 m
Swath	20 km
Revisit	Constellation
Spectral range	8-10.7 μm
Band count	25
Absolute radiometric uncertainty	<10% @ 300 K
NE∆T	<0.4 K at 300 K



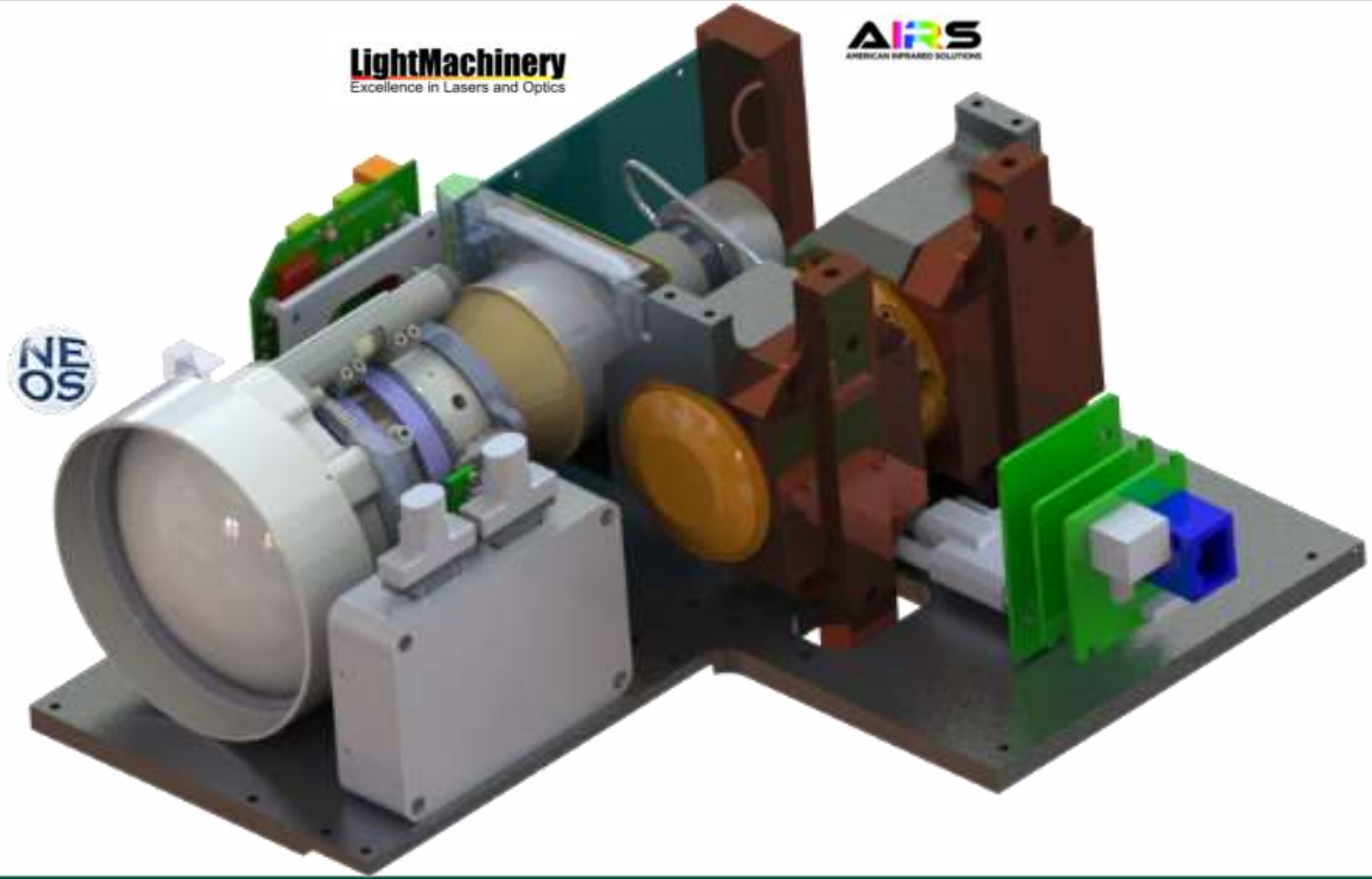
TIRCIS (44 cm^{-1})



HyTI design



HyTI interferometric LWIR imager



HyTI subsystems

Syrlinks

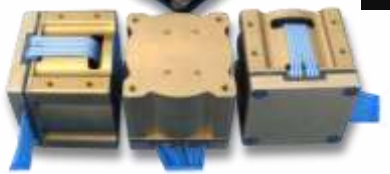
ISIS

UNIBAP

ISIS

NSL

CUBE SPACE



ISIS

HyTI will process from L0 to L2 onboard using a dedicated OBC

Raw Frame Collection

- IDCA to Camera Link to RAM
- Read and subtract sky background
- 2 Bytes x 320 Columns x 512 Rows x 160 Frames per Second

Registration and Stacking

- RAM to Disk
- Reorder data into interferometrically stacked "Tiles" of geometrically registered data
- 2 Bytes x 320 Columns (@60M) x 666 Rows (@60M) x 462 Planes per Tile

Level 0 Storage

- Accumulate Tiles over sufficient orbits to cover CONUS
- ~65 GiB per day

Contact Point Shift and Transform

- Disk to RAM
- Interferogram for each image element
  - Cubic Spline interpolation
  - Zero mean subtraction
  - Triangular apodization
  - Discrete Cosine Transform
- 2 Bytes x 320 Columns x 666 Rows x 25 Channels per Tile

Radiometric Calibration

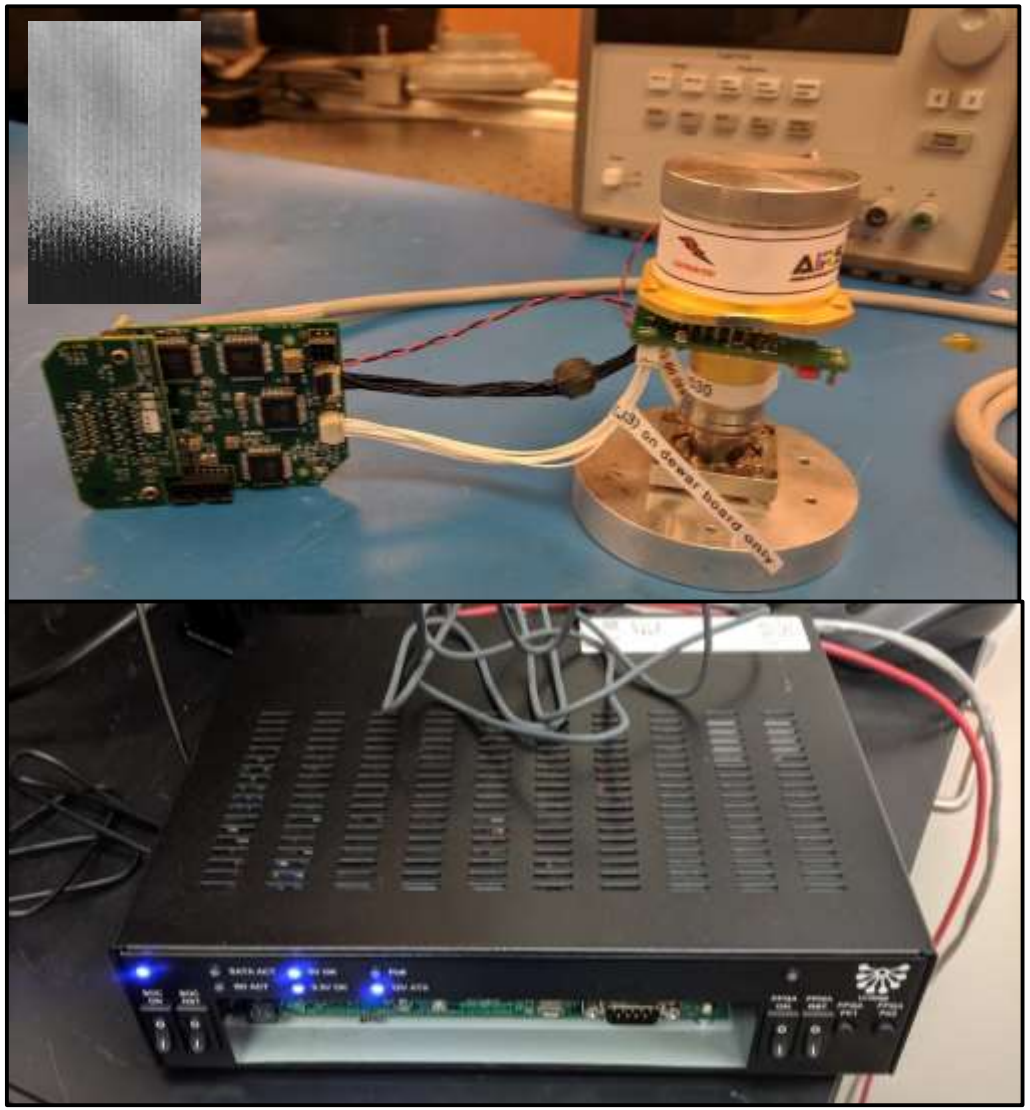
- RAM to Disk
- Multiply each Spectrum by column specific transfer function
- 2 Bytes x 320 Columns x 666 Rows x 25 Channels per Tile

Level 1 Storage

- Store Tiles for subsequent downlink
- ~ 3.5 GiB per day

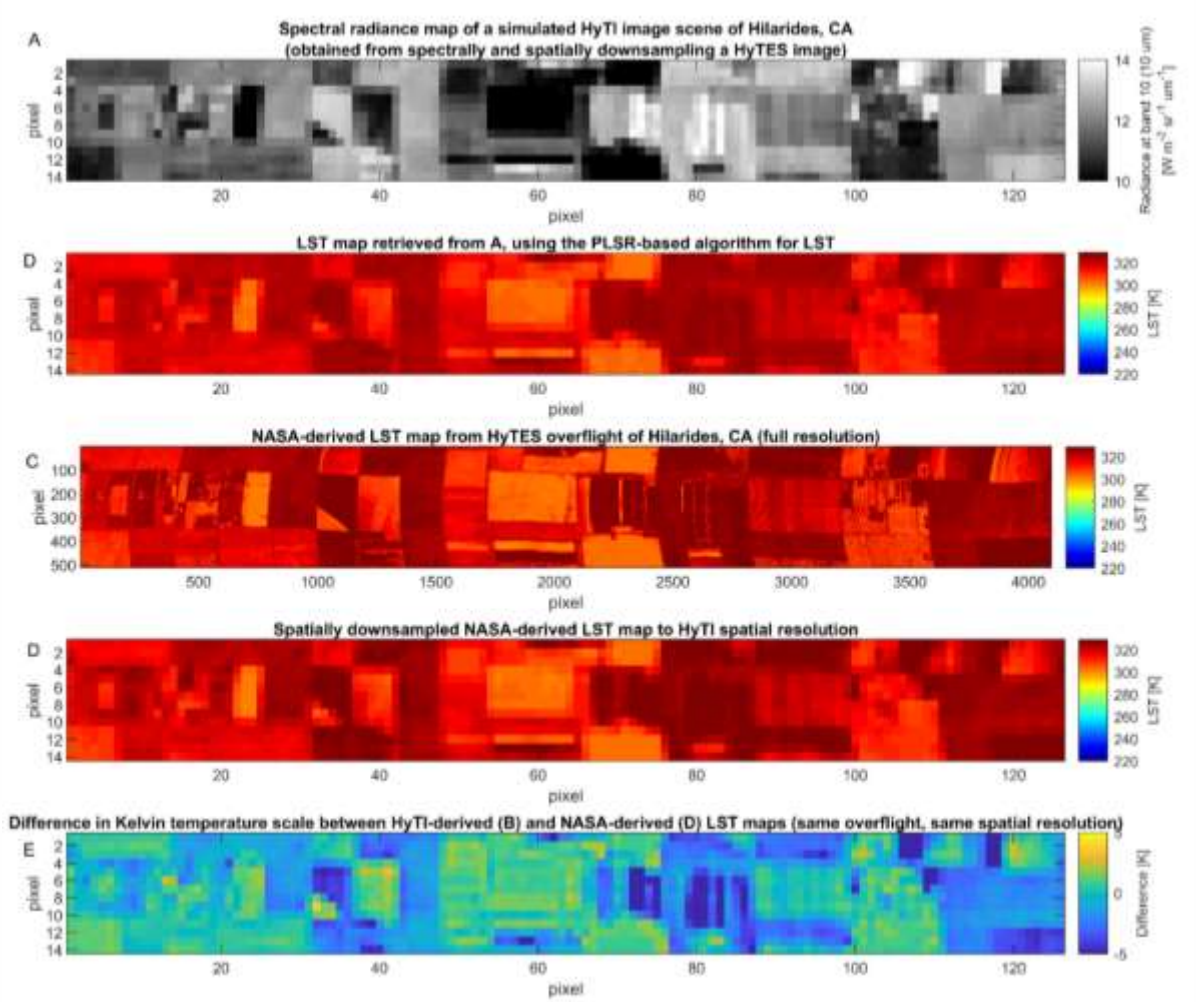
Downlink

- Downlink accumulated tiles
- ~ 1.5 GiB per day (@ 2.5 x compression)

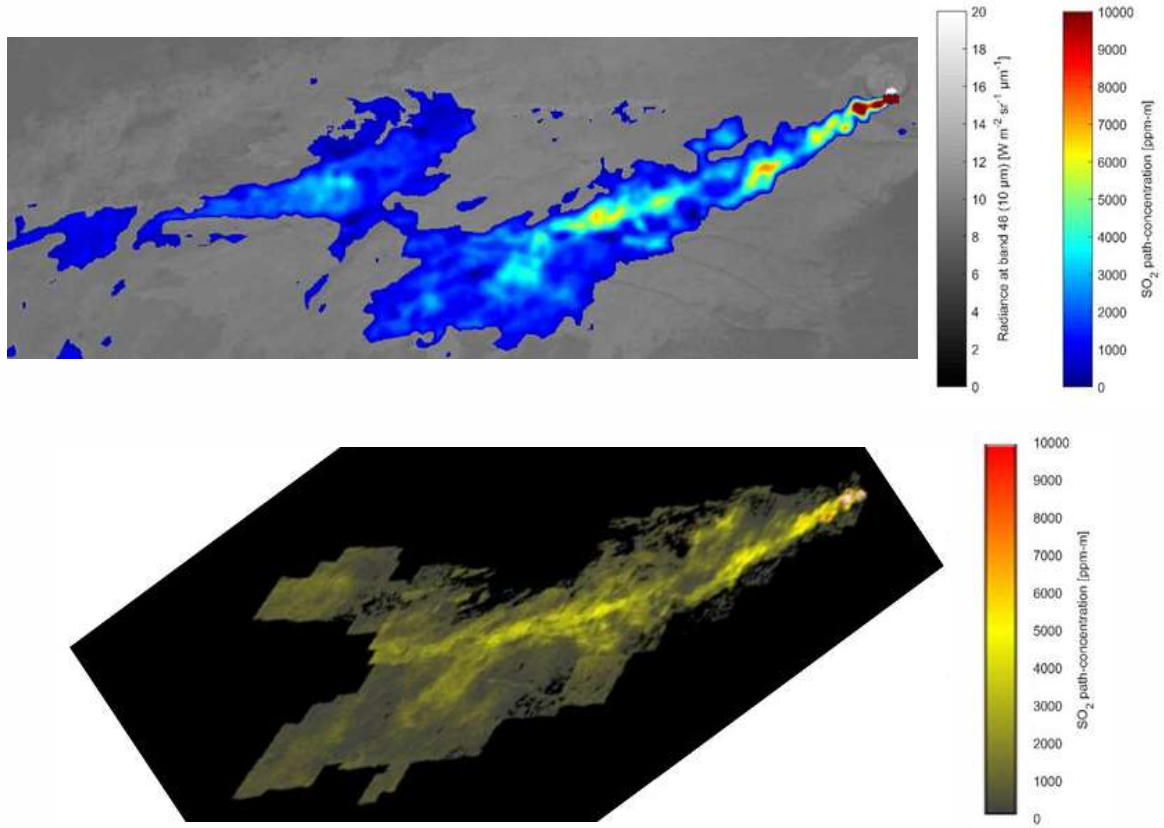


Science data products will be generated on-board HyTI

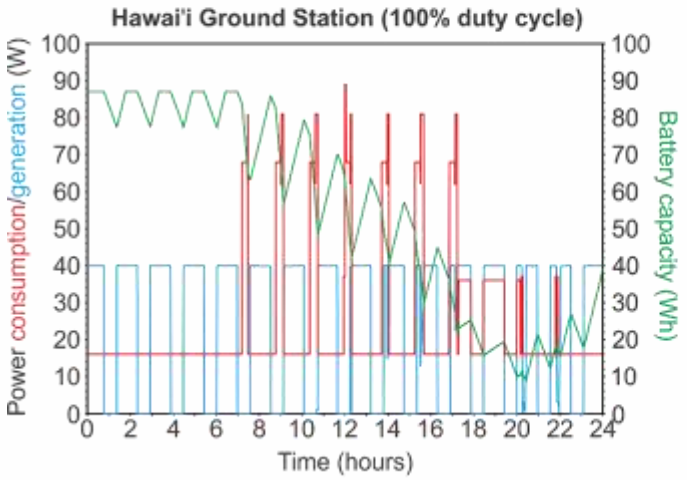
Land Surface Temperature (LST, K)

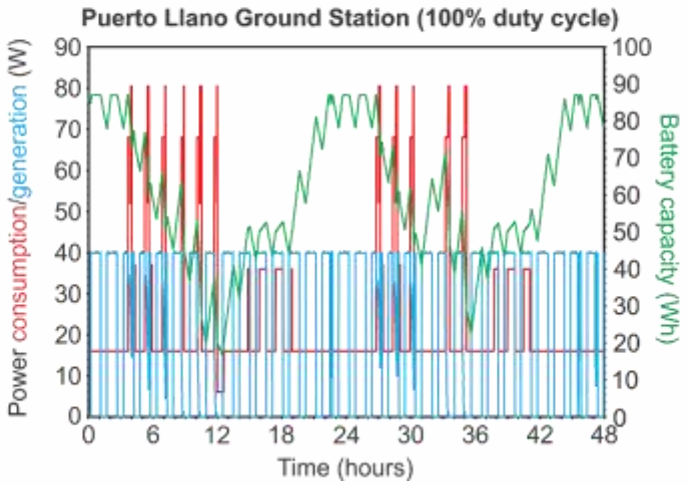


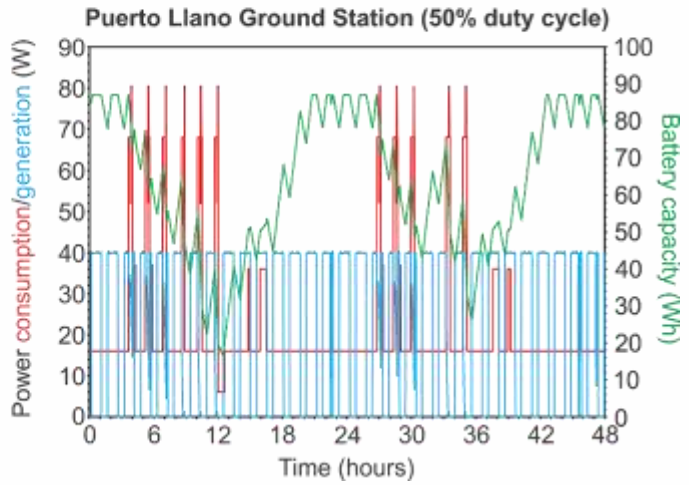
Volcanic SO_2 concentrations (ppm.m)



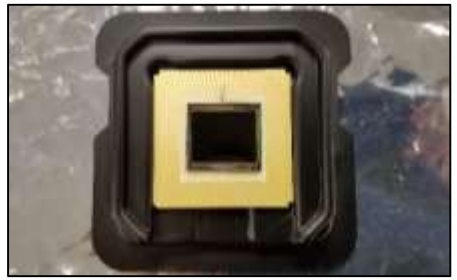
HyTI, Day-in-the-life

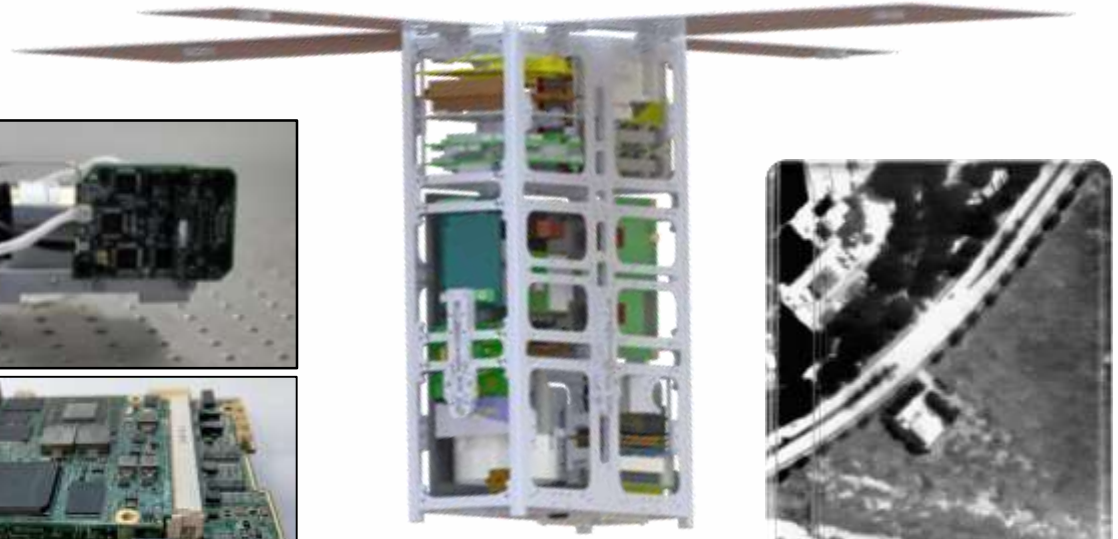


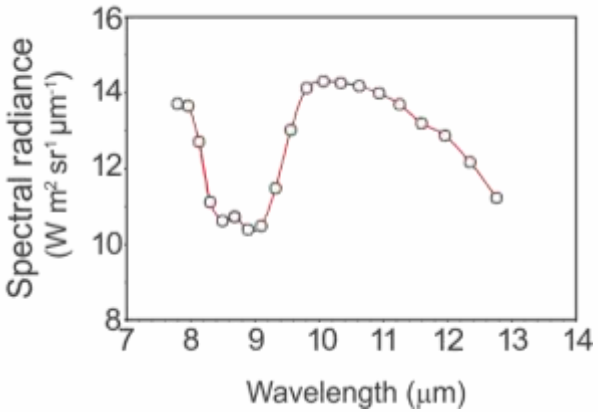




Summary







Space-validating innovative new technology to provide Earth scientists with high spatial and spectral resolution thermal infrared image data from a 6U cubeSat

Acknowledgements:

1. Funding from *NASA Earth Science Technology Office's InVEST program* (80NSSC18K1601)
2. Co-Is and collaborators: Paul Lucey, Miguel Nunes, Luke Flynn (UH Mānoa); Sarath Gunapala, Sir Rafol, David Ting, Alex Soibel (JPL); Lloyd French (Qwest Inc.); Carl Kirkconnell (West Coast Solutions); Dan Manitakos and Bob Papinsick (AIRS), Tom George (SaraniaSat); Peter Kornick, Greg Fitzgerald and team (New England Optical Systems, now FLIR); Benoit Chamot and team at ISIS